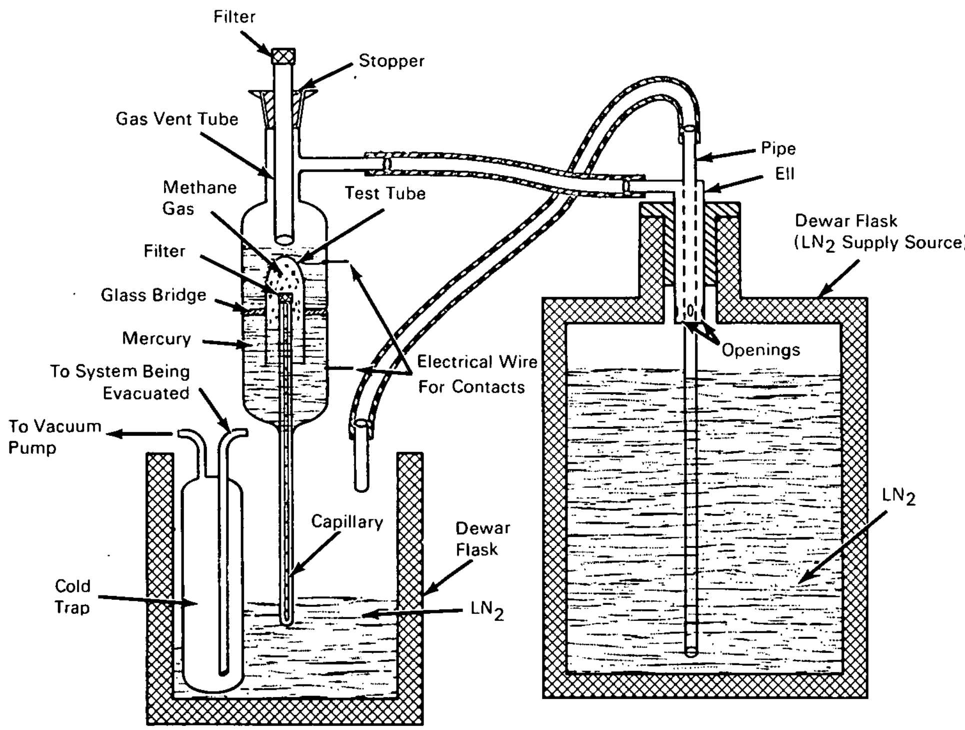
NASA TECH BRIEF

Control for Maintaining Constant Level of a Cryogenic Liquid



The problem:

Maintain a constant level of a cryogenic liquid in a vessel simply and automatically. This will ensure effective operation of a cold trap when the cryogenic liquid is used to cool the trap for a vacuum system. The constant loss of this liquid as it changes to gas and boils off to the atmosphere must be replenished. Temperature changes of the cryogen cause changes in temperature in the operating vessel.

The solution:

Use an arrangement powered by the buildup of pressure as the cryogenic liquid vaporizes to pump the liquid from a storage reservoir. Changes in volume of a gas such as methane, resulting from changes in temperature in the operating vessel, actuate a valve which either replenishes the depleted liquid in the vessel or vents the evolving gas to the atmosphere.

How it's done:

In the drawing, the valve is connected so that it initially allows venting of gaseous nitrogen from a supply reservoir of liquid nitrogen (LN_2), a cryogenic liquid, to the atmosphere to prevent pressure buildup within the reservoir. When replenishment is required in the vessel as indicated by an increase in tempera-

(continued overleaf)

ture, the valve is actuated by an increased volume of methane gas to discontinue venting and to direct the pressurized nitrogen gas to pump liquid nitrogen from the supply reservoir. This continues until the desired level in the vessel is reestablished, at which time the resulting temperature drop in the vessel causes a reduction in the volume of methane gas. This returns the valve to its initial state to resume venting.

Reference to the drawing will assist in understanding the following detailed description of the control arrangement. A Dewar flask is the cryogenic liquid storage reservoir. It is connected by pipe and flexible tubing to the supply inlet of a second Dewar flask containing some liquid nitrogen (LN_2) for cooling a cold trap which is part of a vacuum system. The level of liquid nitrogen, which should be maintained constant, is indicated.

Glass members shown in schematic form in the drawing constitute the elements of the control device. The tubular main body portion has a hollow downward extension resembling a thermometer tube with a capillary bore and a closed off end. This body portion also has a somewhat larger diameter upward tubular extension provided with a laterally extending sidearm connection. The upward tubular extension is normally closed off by a removeable stopper which supports a centrally disposed gas vent tube. A filter is fitted on the upper end of this tube.

The sidearm is connected by flexible tubing with the inlet portion of an ell coaxially surrounding the pipe which extends downward into the pool of liquid nitrogen in the reservoir. The ell is provided with a series of openings.

An inverted section of the test tube is supported in a fixed position concentric with the bore of the main body portion by means of glass bridges. The interior of the test tube and the capillary bore of the downward extension contain methane gas of a volume chosen so that a pool of mercury within the main body portion not only surrounds the test tube, but also extends part way upwardly within its interior. To prevent mercury from entering the capillary bore under certain operating conditions, the upper end of the extension is fitted with a filter which admits methane but not mercury.

The lower end of the downward extension is close to the liquid nitrogen in the Dewar flask containing the cold trap; hence, methane gas in the capillary and interior of the test tube is cooled. Since cooled methane occupies a smaller volume, the mercury in the pool rises within the interior of the test tube. This opens the lower end of the gas vent tube, and gaseous nitrogen vaporizing from the liquid nitrogen supply in the reservoir can pass through openings into the ell and through the flexible tubing, side arm, gas vent tube, and filter to the atmosphere. Since the vaporized nitrogen is under pressure, the filter on the upper end of the gas vent tube is sealed against entry of air under atmospheric pressure.

When the level of liquid nitrogen in the Dewar flask containing the cold trap drops sufficiently, the temperature rises therein. This causes expansion of the methane gas in the capillary and test tube, driving mercury from the interior of the test tube. The level of mercury then rises within the bore of the main body portion blocking off the lower end of the gas vent tube and thus closing off the vent passage. Since the evolving gaseous nitrogen can no longer escape, pressure builds up within the reservoir. This drives liquid nitrogen upward through the pipe, tubing, and inlet into the other Dewar flask.

When sufficient liquid nitrogen has been added to the contents of this flask, the temperature drops causing a reduction of volume of the methane. This reopens the escape passageway through the gas vent tube allowing venting to the atmosphere and relieving the builtup pressure within the reservoir. Pumping of liquid nitrogen then stops.

Notes:

1. Use of the device as a methane operated switch is advantageous because of its high reliability in unattended operation.
2. No further documentation is available. Inquiries may be directed to:

   Technology Utilization Officer
   NASA Pasadena Office
   Pasadena, California 91103
   Reference: B69-10573

Patent status:

No patent action is contemplated by NASA.

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